Role of Video Games in Improving Health-Related Outcomes

A Systematic Review

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Appendix A

Research Protocol

I. Research Question

Can video games be used as effective interventions in promoting health and/or improving health outcomes?

Further Definition of Research Question:

1. Population
    a. Both genders
    b. No age limitations
2. Intervention
    a. Definition of video game (American Heritage Dictionary 2006): "An electronic or computerized game played by manipulating images on a video display or television screen."
    b. In order to be a "game," it must:
        i. Have a system of reward, incentive, and/or objective
        ii. Be interactive and/or competitive
        iii. Be designed for recreational use (i.e., be designed to be "fun")
    c. Any dose/intensity acceptable
    d. Any length acceptable
    e. Intervention should be targeted for a particular purpose (see outcome)
3. Control
    a. Must compare to either nothing, other treatment that does not involve video games, or different (control-type) video game
    b. Specifically exclude comparison of doses
4. Outcome
    a. Improvement/positive health consequence
    b. Goal is to improve a condition for which there is
        i. An ICD-9 code
        ii. An outcome for which there is a likely association with an ICD-9 code

II. Selection Criteria

Major criterion	Further definition of criterion	Example satisfying this criterion	Example not satisfying this criterion
1. An included study must test the effect of video games on a positive, clinically relevant health consequence.			
	1A. A "positive, clinically relevant health outcome" means the alleviation of a condition classified as a disorder by the ICD-9 system.	A study testing the effect of a video game on asthmatic exacerbations fulfills this criterion.	A study testing the ability of video games to worsen a health condition (such as aggression, ADHD, substance use, or eating disorders) does not fulfill this criterion.
	1B. A "positive, clinically relevant health outcome" can be an outcome with an association with an ICD-9 code (as opposed to an ICD-9 code itself).	A study testing the effect of a video game on knowledge of how to manage asthma exacerbations fulfills this criterion. A study testing the ability of a video game to improve self-esteem is acceptable since self-esteem is associated with diagnoses such as depression.	A study testing the effect of a video game on improving hand–eye coordination in normal participants does not fulfill this criterion, since hand–eye coordination is not unambiguously associated with any ICD-9 code.
	1C. A study meets the criterion of testing a "positive, clinically relevant health consequence" if it has a positive effect on healthcare providers that is likely to improve outcomes in patients.	A study testing the effect of a video game on improving a surgeon's skill satisfies this criterion.	A study testing the effect of a video game on the desire of nurses to take fewer vacation days does not fulfill this criterion, since that desire is not necessarily associated with improved patient outcomes.
2. An included study must use as its intervention a video game.			
	2A. A video game is defined as "An electronic or computerized game played by manipulating images on a video display or television screen" (American Heritage Dictionary).	A study testing the effect of "Dance Dance Revolution" on BMI fulfills this criterion.	A study testing the effect of an interactive, computer-based tutorial system that is primarily text does not fulfill this criterion.
	2B. The study must compare the intervention video game to (1) nothing; (2) a different treatment that does not involve video games; or (3) a different (control-type) video game.	A study that compares an experimental video game related to asthma management against a control video game (*Indiana Jones and the Temple of Doom*) is acceptable.	A study that compares one dose of an asthma-related game to another dose of an asthma-related game does not fulfill these criteria. Also, a study that tests the effects of different types of subliminal messages in the background of the same video game does not fulfill these criteria.

Major criterion	Further definition of criterion	Example satisfying this criterion	Example not satisfying this criterion
	2C. If the intervention is multimodal, at least 50% of it must involve the video game.	An intervention that consists of 6 hours of video games and 1 hour of exercise weekly is acceptable.	An intervention that consists of playing with a self-selected combination of bubbles, books, a music table, and/or handheld video games is not acceptable.
3. Must be an RCT			
	3A. Participants must be randomly assigned to study groups.	A study that randomly assigns different classrooms to receive a video game or a control intervention is acceptable.	An observational study does not fulfill this criterion.
	3B. Study must involve at least one control group.	A study that involves an attention control or a wait-list control group is acceptable.	A study that follows 20 children who all have exposure to a video game is not acceptable.
	3C. Study must use experimental methods to test the effectiveness of an intervention.	A study that allocates volunteers to receive active video games or counseling to reduce BMI fulfills this criterion.	A review, opinion, policy statement, or quasi-experimental study does not fulfill this criterion.

ADHD, attention deficit hyperactivity disorder

III. Major variables assessed during data extraction

1. **Logistic**
    a. Unique ID Number
    b. Full reference
    c. Year
    d. Location
    e. Funding Source
2. **Sample**
    a. N total
    b. *n* analyzed
    c. *n* intervention
    d. *n* control
    e. Follow-up rate
    f. Age range
    g. Age mean
    h. Age SD
    i. Percentage female
    j. Provider status (patients vs healthcare providers and subjects)
3. **Intervention**
    a. Health topic

b. Type of game
c. Description of game
d. Frequency of sessions (per week)
e. Length of sessions
f. Number of weeks

4. Control

a. Control type (e.g., no video game or control-type video game)
b. Description of control
c. Frequency of sessions (per week)
d. Length of sessions
e. Number of weeks

5. Outcome

a. Assessment timing
b. Main outcome measure
c. Scale range for main outcome measure
d. Baseline control
e. Baseline intervention
f. Follow-up control
g. Follow-up intervention
h. Statistical test used
i. Overall results
j. Secondary outcome(s)
k. Overall results for each secondary outcome

6. Quality

a. Blinding
b. Concealment of allocation
c. Intention-to-treat analysis
d. Other comments regarding quality

7. Additional comments

Appendix B

Database search strategies

Database	Search strings used
Center on Media and Child Health Database of Research	(“video game” [Title/Keyword/CMCH Abstract/CMCH Synopsis] OR “videogame” [Title/CMCH Abstract/Keyword/CMCH Synopsis] OR “gaming” [Title/Keyword/CMCH Abstract/CMCH Synopsis] OR “computer game” [Title/Keyword/CMCH Abstract/CMCH Synopsis]) AND (“random” [Title/Keyword/CMCH Abstract/CMCH Synopsis] OR “clinical” [Title/Keyword/CMCH Abstract/CMCH Synopsis] OR “therapeutic” [Title/Keyword/CMCH Abstract/CMCH Synopsis] OR “positive” [Title/Keyword/CMCH Abstract/CMCH Synopsis]
PubMed	(atari[Title/Abstract] OR space invader*[Title/Abstract] OR death race[Title/Abstract] OR pac man[Title/Abstract] OR battlezone[Title/Abstract] OR astrocade[Title/Abstract] OR donkey kong[Title/Abstract] OR coleco[Title/Abstract] OR tetris[Title/Abstract] OR sega[Title/Abstract] OR super mario[Title/Abstract] OR sonic the hedgehog[Title/Abstract] OR street fighter[Title/Abstract] OR mortal kombat[Title/Abstract] OR pokemon[Title/Abstract] OR frogger[Title/Abstract] OR dreamcast[Title/Abstract] OR grand theft auto[Title/Abstract]) OR (video gam*[Title/Abstract] OR videogam*[Title/Abstract] OR computer gam*[Title/Abstract] OR online gam*[Title/Abstract] OR game system*[Title/Abstract] OR gaming system*[Title/Abstract] OR arcade gam*[Title/Abstract] OR nintendo[Title/Abstract] OR xbox[Title/Abstract] OR playstation*[Title/Abstract] OR MMORPG*[Title/Abstract] OR interactive gam*[Title/Abstract] OR gamer*[Title/Abstract] OR gaming[Title/Abstract] OR game console*[Title/Abstract] OR gaming console*[Title/Abstract] OR digital gam*[Title/Abstract] OR handheld gam*[Title/Abstract] OR console gam*[Title/Abstract] OR multiplayer*[Title/Abstract] OR gameplay*[Title/Abstract] OR game boy*[Title/Abstract] OR game cube*[Title/Abstract]) OR (("Video Games"[Mesh] OR "Play and Playthings"[Mesh:noexp]) AND (Computer*[Title/Abstract] OR video*[Title/Abstract]))
Ovid CINAHL	1. video gam$.tw. 2. videogam$.tw. 3. computer gam$.tw. 4. online gam$.tw. 5. game system$.tw. 6. gaming system$.tw. 7. arcade gam$.tw. 8. Nintendo.tw. 9. Xbox.tw. 10. playstation$.tw. 11. MMORPG.tw. 12. interactive gam$.tw. 13. gamer$.tw. 14. gaming.tw. 15. game console$.tw. 16. gaming console$.tw. 17. digital gam$.tw. 18. handheld gam$.tw. 19. console gam$.tw. 20. multiplayer$.tw. 21. gameplay$.tw. 22. game boy$.tw. 23. gameboy$.tw. 24. game cube$.tw. 25. gamecube$.tw. 26. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 27. atari.tw. 28. space invader$.tw. 29. death race.tw. 30. pong.tw. 31. pac man.tw. 32. pacman.tw. 33. battlezone.tw. 34. astrocade.tw.

	35. donkey kong.tw. 36. coleco.tw. 37. tetris.tw. 38. sega.ti,ab. 39. super mario.tw. 40. (sonic adj2 hedgehog).tw. 41. street fighter.tw. 42. mortal kombat.tw. 43. pokemon.tw. 44. frogger.tw. 45. dreamcast.tw. 46. grand theft auto.tw. 47. 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 48. Video Games/ 49. 26 or 47 or 48 50. randomized.tw. 51. Treatment Outcomes/ 52. clinical trial.pt. 53. 50 or 51 or 52 54. 49 and 53
PsycINFO	1. Computer Games/ 2. Simulation Games/ 3. GAMES/ 4. exp COMPUTERS/ 5. INTERNET/ 6. 4 or 5 7. 3 and 6 8. 1 or 2 or 7 9. video gam$.tw. 10. videogam$.tw. 11. computer gam$.tw. 12. online gam$.tw. 13. game system$.tw. 14. gaming system$.tw. 15. arcade gam$.tw. 16. Nintendo.tw. 17. Xbox.tw. 18. playstation$.tw. 19. MMORPG.tw. 20. interactive gam$.tw. 21. gamer$.tw. 22. gaming.tw. 23. game console$.tw. 24. gaming console$.tw. 25. digital gam$.tw. 26. handheld gam$.tw. 27. console gam$.tw. 28. multiplayer$.tw. 29. gameplay$.tw. 30. game boy$.tw. 31. gameboy$.tw. 32. game cube$.tw. 33. gamecube$.tw. 34. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 35. atari.tw. 36. space invader$.tw. 37. death race.tw. 38. pong.tw. 39. pac man.tw. 40. pacman.tw. 41. battlezone.tw.

	42. astrocade.tw. 43. donkey kong.tw. 44. coleco.tw. 45. tetris.tw. 46. sega.ti,ab. 47. super mario.tw. 48. (sonic adj2 hedgehog).tw. 49. street fighter.tw. 50. mortal kombat.tw. 51. pokemon.tw. 52. frogger.tw. 53. dreamcast.tw. 54. grand theft auto.tw. 55. 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 56. 8 or 34 or 55 57. double blind.tw. 58. random$ assigned.tw. 59. control.tw. 60. 57 or 58 or 59 61. 56 and 60
EMBASE	(('video game' OR 'video games' OR 'video gamer' OR 'video gamers' OR 'video gaming') OR (videogame OR videogames OR videogamer OR videogamers OR videogaming) OR ('computer game' OR 'computer games' OR 'computer gamer' OR 'computer gamers' OR 'computer gaming') OR ('online game' OR 'online games' OR 'online gamer' OR 'online gamers' OR 'online gaming') OR ('game system' OR 'games system' OR 'gamer system' OR 'gamers system' OR 'gaming system') OR ('game systems' OR 'games systems' OR 'gamer systems' OR 'gamers systems' OR 'gaming systems') OR ('arcade game' OR 'arcade games' OR 'arcade gamer' OR 'arcade gamers' OR 'arcade gaming') OR (playstation OR playstations) OR ('interactive game' OR 'interactive games' OR 'interactive gamer' OR 'interactive gamers' OR 'interactive gaming') OR (gamer OR gamers) OR ('game console' OR 'game consoles') OR ('gaming console' OR 'gaming consoles') OR ('digital game' OR 'digital games' OR 'digital gamer' OR 'digital gamers' OR 'digital gaming') OR ('handheld game' OR 'handheld games' OR 'handheld gamer' OR 'handheld gamers' OR 'handheld gaming') OR ('console game' OR 'console games' OR 'console gamer' OR 'console gamers' OR 'console gaming') OR (multiplayer OR multiplayers) OR (gameplay OR gameplayer OR gameplayers OR gameplaying) OR ('game boy' OR 'game boys') OR ('game cube' OR 'game cubes') OR (nintendo OR xbox OR mmorpg OR atari OR 'space invader' OR 'space invaders' OR 'death race' OR 'pac man' OR battlezone OR astrocade OR 'donkey kong' OR coleco OR tetris OR 'super mario' OR 'sonic the hedgehog' OR 'street fighter' OR 'mortal kombat' OR pokemon OR frogger OR dreamcast OR 'grand theft auto') OR (sega:ab,ti OR pong:ab,ti)) AND (random* OR placebo* OR 'placebo'/de OR 'placebo effect'/de OR 'double blind' OR 'double blinding' OR 'double blinded')
CENTRAL	#1 MeSH descriptor Video Games exp #2 (gaming system*):ti,ab,kw #3 (arcade gam*):ti,ab,kw #4 (nintendo):ti,ab,kw #5 (xbox):ti,ab,kw #6 (playstation*):ti,ab,kw #7 (gaming console*):ti,ab,kw #8 (digital gam*):ti,ab,kw #9 (handheld gam*):ti,ab,kw #10 (console gam*):ti,ab,kw #11 (multiplayer*):ti,ab,kw #12 (gameplay*):ti,ab,kw #13 (game boy*):ti,ab,kw #14 (game cube*):ti,ab,kw #15 (MMORPG):ti,ab,kw #16 (interactive gam*):ti,ab,kw #17 (gamer*):ti,ab,kw #18 (game console*):ti,ab,kw #19 (atari):ti,ab,kw #20 (space invader*):ti,ab,kw #21 "death race":ti,ab,kw #22 "pac man":ti,ab,kw #23 (battlezone):ti,ab,kw

	#24 (astrocade):ti,ab,kw #25 "donkey kong":ti,ab,kw #26 (coleco):ti,ab,kw #27 (tetris):ti,ab,kw #28 "super mario":ti,ab,kw #29 "street fighter":ti,ab,kw #30 "mortal kombat":ti,ab,kw #31 (pokemon):ti,ab,kw #32 (frogger):ti,ab,kw #33 (dreamcast):ti,ab,kw #34 "grand theft auto":ti,ab,kw #35 (video gam*):ti,ab,kw #36 (videogam*):ti,ab,kw #37 (computer gam*):ti,ab,kw #38 (online gam*):ti,ab,kw #39 (game system*):ti,ab,kw #40 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39)

$, use truncation; *, use truncation; Ab, abstract; CENTRAL, Cochrane Central Register of Controlled Trials; exp, explode; Kw, search all fields; MeSH, previously assigned subject heading; Ti, title; Tw, search all fields

Appendix C

PRISMA checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3–4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5–7
Objectives	4	Provide an explicit statement of questions being addressed with reference to PICOS.	8
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., web address), and, if available, provide registration information including registration number.	Appendix 1
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	8–10
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	11
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 2
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8–11
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	12, Tables, Appendix 1, Appendix 4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12, Appendix 4
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	12–13
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	13
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	13
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	13

RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	14, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	14–16, Table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see item 12).	16–17
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group; (b) effect estimates and CIs, ideally with a forest plot.	16–17, Tables 1–2 (Forest plot N/A)
Synthesis of results	21	Present results of each meta-analysis done, including CIs and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	13
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	16–17, Table 2
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policymakers).	18–21
Limitations	25	Discuss limitations at study- and outcome-level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	21–22
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	22
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	23

Note: Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6(6): e1000097; doi:10.1371/journal.pmed1000097.
N/A, not applicable; PICOS, participants, interventions, comparisons, outcomes, and study design; PRISMA, preferred reporting items for systematic reviews and meta-analyses

Appendix D

Study characteristics of RCT of effects of video games on health outcomes

Reference	Health topic	N[a]	Age (M, years)	Intervention	Control	Primary outcome	Outcome results[d]
Physical therapy							
Fitzgerald (2010)[1]	Postural instability	22	26	*Neverball*: PC-based, interactive game in which the player uses a wobble board–based system to maneuver a ball along a terrain with obstacles	Wobble-board maneuvering only (no video game)	Balance	–
Broeren (2008)[2]	Stroke rehabilitation	22	68	A custom three-dimensional virtual reality environment in which participants reach into virtual space and manipulate objects	Standard rehabilitation (no video game)	Manual ability	+
Brumels (2008)[3]	Postural instability	25	20	*Wii Fit™* and *Dance Dance Revolution™*: Interactive video games for Playstation® 2 that simulate sports and dancing and require body movement on floor mats and/or platforms to play	Traditional balance program (no video game)	Balance	+
Cameirao (2008)[4]	Stroke rehabilitation	14	61	*Rehabilitation Gaming System*: A virtual reality–based apparatus designed for rehabilitation of the upper extremities	Conventional therapy, plus similar motor tasks to intervention (no video game; Control A) and nonspecific games on the Nintendo® Wii™ (Control B)	Recovery from stroke	+
Jannink (2008)[5]	Cerebral palsy	10	12	Various games on the *EyeToy: Play®* system: active games in which participants must make gross elbow and shoulder movements to manipulate objects on a virtual screen	Routine physiotherapy program (no video game)	Unilateral upper limb function	–
Yavuzer (2008)[6]	Stroke rehabilitation	20	61	Playstation *EyeToy® Play2™* games including "Kung Foo," "Goal Attack," "Mr. Chef," and others utilizing flexion and extension of the affected shoulder, elbow, and wrist	Conventional treatment program (no video game)	Motor recovery	+
Lin (2007)[7]	Knee osteoarthritis	81	61	Game in which participants control movements of a snake using their feet and score points when they catch prey	Health education regarding knee osteoarthritis (no video game)	Absolute reposition error	+

Jarus (2000)[8]	Wrist fracture	47	59	*Revenge of Doh (*also known as *Arkanoid)* for Playstation®*:* arcade-type game similar to *Breakout* in which player must manipulate a paddle horizontally to hit a ball into objects at the top of the screen	Modified machine for making brushes requiring participant to pronate and supinate the hand (no video game)	Range of motion	–
Psychological therapy							
Holmes (2009)[9]	Post-traumatic stress disorder	40	23	*Tetris*®: puzzle-like game in which player manipulates falling shapes in order to fit them together using space efficiently	No video game	Flashback frequency	+
Russoniello (2009)[10]	Anxiety	134	24	*Bejewled 2™* (matching, sequencing game), *Bookworm Adventures™* (word-making game) or *Peggle* ™ (a pinball-like game)	Completion of Internet task involving searching for health-related articles and placing them in a folder	Mood	+
Basak (2008)[11]	Cognitive decline in elderly	39	70	*Rise of Nations*®: Real-time strategy game in which the goal is to build new cities, improve national infrastructure, and expand country border	No video game	Executive control skills	–
Jimenez (2008)[12]	Dyslexia	62	11	*Trasdislexia*: Multimedia game in which the participant interacts with characters on the screen to manipulate letters and create words	Lecture in a traditional classroom setting (no video game)	Phonological awareness	+
Rezaiyan (2007)[13]	Attention capacity	60	NR[c]	Path-finding (maze-like) game	No video game	Attention capacity	+
Baccus(2004)[14]	Self-esteem	118	19	Computerized conditioning game in which self-relevant words were always paired with an image of a smiling face	Same game but with random pairings of faces and words	Implicit self-esteem	+
Goldstein (1997)[15]	Age-related decrease in reaction time	22	78	*Super Tetris:* PC-based puzzle-like game for Nintendo® in which player manipulates falling shapes in order to fit them together using space efficiently	No video game	Reaction time	+
Disease self-management							
Kato (2008)[16]	Juvenile cancer	304	13–29[b]	*Re-Mission®:* action game in which players carry out missions inside three-dimensional models of 19 different young patients being treated for cancer	*Indiana Jones® and the Emperor's Tomb™* action video game	Medication adherence	+
Kumar (2004)[17]	Type I diabetes	40	14	*DiaBetNet™*: motivational game using wireless technology in which participants gain points for correctly predicting glucose levels based on prior information	Wireless report of blood glucose data, insulin doses, and carbohydrate intake (no video game)	Transmission of blood glucose values	+

Shames (2004)[18]	Asthma	97	8	*Bronkie's Asthma Adventure*®: simulation game for Super Nintendo® in which participants guide a dinosaur with asthma named Bronkie to healthy behaviors	Usual asthma care and nonviolent Super Nintendo video game (does not specify which particular games)	Frequency of asthma symptom days	–
Bartholomew (2000)[19]	Asthma	133	12	*Watch, Discover, Think, Act*: adventure game in which player makes choices to manage a fictional character's asthma	Continued regularly scheduled appointments and patient education (no video game)	Self-efficacy of asthma self-care	–
Health education							
Pempek (2009)[20]	Nutrition	30	10	Modified *Pac-Man* game in which participants were awarded points for "eating" nutritious on-screen snacks and penalized for "eating" unhealthy snacks	A similar video game in which nutritious choices were penalized and unhealthy ones rewarded (Control A) and no video game (Control B)	Snack and beverage choices	+
Peng (2009)[21]	Nutrition	40	20	*RightWay Café*: simulation game in which participants compete to most effectively manage diet and exercise behaviors in a hypothetic reality-TV program	No video game	Nutrition knowledge	+
Beale (2007)[22]	Juvenile cancer	371	16	*Re-Mission*®: action game in which players carry out missions inside three-dimensional models of 19 different young patients being treated for cancer	*Indiana Jones*® action video game	Cancer knowledge	+
Huss (2003)[23]	Asthma	101	10	*Wee Willie Wheezie:* PC-based adventure game in which the player must maneuver through various environments while avoiding allergens and utilizing asthma medications in a timely fashion	Asthma reading material and *Magic School Bus Explores the Body* video game in which players explore the human body	Asthma symptoms	–
Yawn (2000)[24]	Asthma	87	10	*Air Academy™: The Quest for Airtopia:* interactive game in which children must use knowledge of asthma management to complete missions in "Planet Poluto," "Mold West," and "King Kough Island" in order to reach "Air-Topia"	Typical health and science classes without asthma information, and regular computer lab without asthma games	Asthma knowledge	+
Brown (1997)[25]	Type I diabetes	59	8-16[b]	*Packy & Marlon:* interactive video game for Super Nintendo® in which two adolescent elephant friends must save a summer diabetes camp from rats and mice who have disrupted the camp's food and diabetes supplies	Pinball video game	Self-efficacy for diabetes self-care	–

Rubin (1986)[26]	Asthma	54	10	*Asthma Command:* simulation game in which participant progresses through a normal school day and is rewarded for avoiding allergens and making choices that avoid exacerbation of asthma	Zaxxon™ (non–asthma related action computer game) and 5–10 minutes asthma management teaching	Asthma knowledge	+
Distraction from discomfort							
Miller (2009)[27]	Burns requiring dressing changes	80	6	A multimodal distraction device that was used for both procedural preparation with interactive story *Bobby Got a Burn* and distraction during dressing changes	Toys, TV, and nursing/caregiver interaction (no video game)	Pain self-report	+
Gold (2006)[28]	IV placement	20	10	*Street Luge*: virtual-reality game from Active Life™ Extreme Challenge for Nintendo® Wii™ in which the player races downhill lying on top of a large skateboard	Topical anesthesia spray prior to IV placement (no video game)	Affective pain	+
Patel (2006)[29]	Preoperative anxiety	112	7	Video game of child's choice	Parent presence (Control A) and oral midazolam (Control B)	Preoperative anxiety	+
Vasterling (1993)[30]	Chemo-therapy distraction	60	51	Participants' choice of video games on an Apple™ Macintosh™ computer	Relaxation techniques (Control A) and no video game (Control B)	Post-chemotherapy systolic blood pressure	+
Seyrek (1984)[31]	Dental pain distraction	80	NR[c]	Ping-pong simulation video game	No video game (Control A); audio comedy show (Control B); and video comedy show (Control C)	Pain	+
Physical activity							
Murphy (2009)[32]	Endothelial function	35	7–12[b]	*Dance Dance Revolution™*: interactive game that simulates dancing and requires body movement on floor mats and/or platforms to play	No video game	Flow-mediated dilation	+
Maloney (2008)[33]	Physical activity	60	8	*Dance Dance Revolution™*: interactive game that simulates dancing and requires body movement on floor mats and/or platforms to play	No video game	Activity level	–
Ni Mhurchu (2008)[34]	Physical activity	20	12	Various on the *EyeToy: Play®* system: active games in which participants must make gross elbow and shoulder movements to manipulate objects on a virtual screen	Regular (non-active) video games	Activity level	+

Warburton (2007)[35]	Physical activity	14	23	*GameBike*® interactive video gaming system in which participants steer while biking through various entertaining terrains (e.g., offroad ATV, NASCAR™)	Standard stationary-bicycle training regimen (no video game)	Adherence	+
Clinician skills							
Schlickum (2009)[36]	Endoscopic skills for doctors	40	20–31[b]	*Half Life*®: first-person shooter game with heavy visuo-spatial demands	*Chessmaster*® chess video game (Control A) or no video game (Control B)	Performance on two virtual-reality endoscopic surgery simulation	+
Sward (2008)[37]	Pediatric content education for medical students	98	27	*MEDGAME*: a web-based interactive game in which teams take turns rolling dice, moving around a virtual game board, and scoring points when they answer questions about pediatrics correctly	Self-study using web-based flash cards	Pediatric knowledge	–
Rosenberg (2005)[38]	Laparoscopic skills for physicians	11	26	*Top Spin™*, *Project Gotham Racing 2™*, and *Amped® 2*: commercially available action games	No video game	Laparoscopy skills	–

[a] The number of participants analyzed.

[b] Mean age was not reported for Brown, Kato, Murphy and Schlickum; thus, age range is presented instead.

[c] For Rezaiyan and Seyrek, neither mean age nor age range was presented.

[d] The plus (+) sign indicates that the video game intervention was superior to control, and the null hypothesis was refuted. The minus (–) sign indicates that the null hypothesis was upheld.

ATV, all-terrain vehicle; NASCAR, National Association for Stock Car Auto Racing; NR, not reported, PC, personal computer

Appendix E

Measurement of study outcomes, length of studies, and intervention frequency

Study	Measurement of outcome	Length of study (M, weeks)	Intervention frequency (M, times per week)
Baccus (2004)[14]	Composite score including name, letter, measure, and implicit association tests	Once	Once
Bartholomew (2000)[19]	23-item child self-efficacy scale for asthma management	30[a]	NR[b]
Basak (2008)[11]	Operation span portion of cognitive battery	5	3
Beale (2007)[22]	18-item cancer knowledge scale	12	1[a]
Broeren (2008)[2]	Block and Box Test	4	3
Brown (1997)[25]	11-item Likert scale on self-efficacy	24	1[a]
Brumels (2008)[3]	Star Excursion Balance Test	4	3
Cameirao (2008)[4]	Chedoke Arm and Hand Activity Index	12	3
Fitzgerald (2010)[1]	Star Excursion Balance Test	12	3
Gold (2006)[28]	FACES Pain Scale-Revised	Once	Once
Goldstein (1997)[15]	Sternberg test	5	5
Holmes (2009)[9]	Number of flashbacks recorded in diary in 1 week	Once	Once
Huss (2003)[23]	Nine symptom questions on Juniper's Pediatric Asthma Quality of Life Questionnaire	12	Once
Jannink (2008)[5]	Melbourne Assessment of Unilateral Upper Limb Function 16-item scale	6	2
Jarus (2000)[8]	Universal goniometer	5	3
Jimenez (2008)[12]	Sicole-R Multimedia Battery, CV segment-synthesis	4	5[a]
Kato (2008)[16]	Assessment of plasma 6-mercaptopurine metabolites and electronic-cap monitoring of medication use	12	1[a]
Kumar (2004)[17]	Number of blood glucose values transmitted	4	7
Lin (2007)[7]	Electrogoniometer	8	3
Maloney (2008)[33]	Actigraph accelerometer	10	6[a]
Miller (2009)[27]	Wong-Baker FACES picture scale	2	2
Murphy (2009)[32]	Ultrasound transducer	12	5[a]
Ni Mhurchu (2008)[34]	Actigraph accelerometer	12	5[a]
Patel (2006)[29]	Modified 22-item Yale Preoperative Anxiety Scale	Once	Once
Pempek (2009)[20]	Number of healthy versus unhealthy snack choices	Once	Once
Peng (2009)[21]	13-item pre-test and 26-item post-test	Once	Once
Rezaiyan (2007)[13]	Toulouse-Pieron Scale	NR	NR[b]
Rosenberg (2005)[38]	Time, errors, and hand–eye on object transfer tasks	2	3[a]
Rubin (1986)[26]	Parcel Knowledge of Asthma Questionnaire	40	1
Russoniello (2009)[10]	EEG (left and right frontal alpha levels)	Once	Once
Schlickum (2009)[36]	MIST-VR tasks	5	1
Seyrek (1984)[31]	Corah Dental Anxiety Scale	Once	Once
Shames (2004)[18]	Percentage of days with asthma symptoms	52	NR
Sward (2008)[37]	100 randomly selected questions from web-based multiple choice test	4	1
Vasterling (1993)[30]	Brachial artery auscultation	11[a]	1[a]
Warburton (2007)[35]	Attendance	6	3[a]
Yavuzer (2008)[6]	Brunnstrom measures	4	7
Yawn (2000)[24]	17-item asthma knowledge test	6	3

[a] Estimated based on information presented in the paper

[b] Insufficient information in the paper to reliably estimate these figures

CV, consonant–vowel; EEG, electroencephalogram; NA, not applicable; NR, not reported

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